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THE MUSHROOM GROWERS'
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CONTENTS

	Page
Editorial : Where it Belongs	549
NFU Case Against Petrol Tax	550
STYSANUS STEMONITIS : Miss D. G. Gandy	551
THE CULTIVATED MUSHROOM—12 : André Sarazin	553
"I HAVE BEEN ASKED" : Dr. R. L. Edwards	562
SINDEN AND HAUSER FOR BRIGHTON EXHIBITION	564
Fred Atkins Alphabet—Q/R	566
"Just the Job" : W. A. B. Harding	568
PUBLICITY : Thoughts and After-Thoughts : Guy V. Reed ...	570
More Publicity Fund Contributions	571

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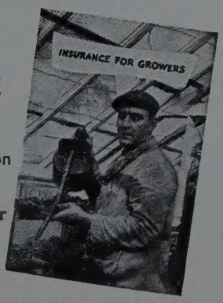

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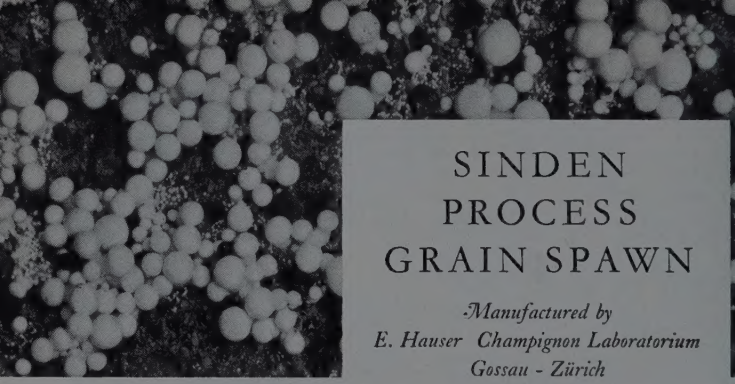

SINDEN PROCESS GRAIN SPAWN

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EDITORIAL: *You will find on this page from time to time some information about spawn which we hope will be interesting to you.*

MUSHROOM growing, once a trade involving secret processes based mostly on tradition, is being modernised by a new generation of scientists and growers. They are breaking down barriers and introducing new methods, step by step, with adventurous minds but cool heads, making changes not only for the sake of being modern, but to increase the efficiency and economy of mushroom plants.

In the early days of this development, twenty-five years ago, when Dr. Sinden was working at the Pennsylvania State College with synthetic compost, one of the major problems he encountered was the great variation of yields from plot to plot planted with the same bottle of manure spawn. Dr. Sinden tackled this problem in his characteristic way by searching for a spawn which would be more uniform in all its particles, which could be spread evenly in the manure and which was economical to make. This led to the invention of Sinden Process Grain Spawn.

In the first tests the beds planted with grain spawn already showed not only a greater uniformity of yield—which meant at the same time a higher yield—but also started to produce earlier. In the course of commercial use it has become in addition more and more evident that the new spawn lends itself in many ways to an improvement of growing technique as well as to an economy in costs, time and work. For many growers, who are to-day in the forefront of the advance, turning their mushroom plants into really efficient enterprises, the initial step has actually been related to the introduction of grain spawn. This is not only true of America where there is probably more pressure for progress in economy among mushroom growers since most of them have all their eggs in one basket, but also of Europe where, for example, one mushroom plant has just finished the first step of remodelling its technique and is now growing two million pounds of mushrooms on the same area—using half the labour—where one million pounds grew three years ago.

Grain spawn comes in clean packages ready to use. At the same time its granular condition lends itself to a diversity of ways of spawning, some of which produce most unforeseen and astounding results. Grain spawn can be stored at 50—60° F. for up to a fortnight and in the cooler at 33—36° F. for some months. Once the mycelium is fully in possession of the grain, it inhibits the growth of most moulds and bacteria. Because each grain has a store of rich food and moisture, the mushroom grows fast and vigorously into the compost as soon as the spawn has been planted. As a result it is now possible to start picking mushrooms regularly twenty-five days after spawning.

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EDITORIAL

WHERE IT BELONGS

The failure of the efforts of the National Federation of Fruit and Potato Trades to launch a publicity fund was not, perhaps, entirely unexpected, but the Federation in informing the NFU that the initiative in this matter must come from the producers themselves certainly places the onus just exactly where it belongs and it may well, in so doing, have caused no surprise at all to those closely connected with the actual production side.

The fact that only twenty per cent. of the Federation members supported the publicity scheme, that 10 per cent. were against and that only 30 per cent. in all bothered to reply, tends to firmly indicate that the fifty per cent. in favour of the MGA original scheme for a small levy on each chip of mushrooms sold was not, in fact, nearly such a poor response as was generally thought at the time and the eight per cent. against did not, in fact, carry the significance which was attributed to it. In the light of the Federation disclosure, the decision of the MGA not to go forward with its Chip Levy Scheme may well appear to have been somewhat hasty.

One thing which emerges above all else from the Federation failure, is the support such a failure gives to the MGA's repeated contention that the publicising of mushrooms is a matter for the producers of that delectable vegetable, first and foremost.

In the recent approaches which have been made to Salesmen asking for support to our publicity effort, some firms have, and quite rightly, pointed out that they had already promised support to the Federation of the general publicity of horticulture and thus did not feel inclined to give further support to any individual section. In an effort to clarify this particular point Mr. Guy Reed, Chairman of the MGA Publicity Sub-Committee visited the Federation Headquarters and was informed that the Federation saw no conflict in the MGA scheme to their own and regarded this scheme of ours as complementary to theirs.

The MGA's repeated assertion, *that individual sections of horticulture would be well advised to look after their individual publicity needs* looks like being fully justified. True, mushrooms enjoy a unique position in the horticultural world, a position fully deserved, let it be added, but mushrooms may well have failed to achieve a single mention in a national "Eat more fruit" or "Eat more vegetables" campaign which the Federation most probably envisaged.

This policy of isolation, in the matter of individual publicity, is one which should be pursued with the utmost vigour, allied to the knowledge that such publicity is, first and foremost, the concern of the mushroom grower.

That being so, the grower, as the actual producer, must be prepared to shoulder his full proportion of the financial outlay since, whilst it is agreed that all sections of the industry must, in the end, benefit, it is the grower who is likely to benefit the most. W.R.A.

NFU STATES THE CASE FOR ABOLITION OF DUTY ON PETROL USED IN AGRICULTURE AND HORTICULTURE

In an eight-page publication the NFU has fully set out its case, to the Government, for the abolition of the tax on petrol used in horticulture and agriculture.

Pointing out that the late Sir Stafford Cripps, when Chancellor of the Exchequer, recognised the need to make an exception of the agricultural industry (including horticulture), when he increased the tax on motor fuel from 9d. to 1/6d. a gallon in 1950, and introduced a scheme to offset this increase (this scheme was withdrawn after a year), the NFU maintain that the present duty of 2/6d. per gallon is both heavy and unjust.

The Union states that in all the most progressive agricultural countries like Denmark, Norway, Switzerland, France, Canada and the U.S.A., petrol used for farm purposes is either exempt altogether from duty or given favourable treatment.

At the beginning of 1954, there were 36,000 four-wheel tractors and 57,000 light tractors, all petrol driven, in use in agriculture and horticulture in the U.K. In that year, 30 million gallons of petrol was used for tractors and 10 million for stationary engines, in the industry, and the amount of duty paid on this fuel, at 2/6d. per gallon, was £5 million.

Claiming that the use of tractor vaporising oil is, in many cases, exceedingly wasteful and that manufacturers are considerably hampered by the consequences of the petrol tax which, in turn, is responsible for a considerable increase in the agricultural industry's production costs, the Union suggests to the Government that, where applicable, horticultural and agricultural producers should purchase their petrol in the ordinary manner and should then be allowed to claim for exemption from tax for all fuel used for non-road purposes. This procedure is similar to that working in connection with the use of petrol in fishing vessels and is similar also to that working satisfactorily in New Zealand, Canada and also in the majority of States in the U.S.A.

Stysanus stemonitis IN MUSHROOM HOUSES

By Miss D. G. Gandy, M.Sc.*
Glasshouse Crops Research Institute

During the emptying of certain houses on a mushroom farm in Kent abnormally large amounts of dust were seen rising from the disturbed beds. A closer investigation showed that the ' dust ' consisted of the spores of a dark grey mould which was growing on the individual straws of the compost and on the damp bed boards.

The fungus was identified as *Stysanus stemonitis* (Pers.) Cda. and this was confirmed by Dr. Dennis, of Kew. It has been recorded as occurring naturally in soil and on decaying vegetable matter.

Stysanus stemonitis on mushroom compost

In the affected beds cropping had been below normal and at the time of inspection *Stysanus* was found in patches where mushroom mycelium was absent and the compost had become dark and damp. There is as yet no evidence to indicate that it is a mushroom competitor and it seems more probable that it develops when conditions are

Mr. J. G. HUGHES

We learn with deep regret of the death of Mr. J. G. Hughes, of Devon Mushrooms Ltd., Ottery St. Mary, who was a founder member of both the MGA and the MRA.

Fascicle of *Stysanus stemonitis*

unfavourable for the growth of mushroom mycelium. In this particular case the importance of the mould lay in the fact that inhalation of the spores produced distressing symptoms in the workers. These symptoms included attacks of shivering, loss of appetite, inflammation of the nose and throat and congestion in the chest. In more severe cases there was persistent nose bleeding. At first these symptoms appeared only after day-long exposure but sensitivity increased until an exposure of only a few minutes could cause a reaction.

Adequate protection has been obtained by the use of respirators fitted with suitable filters.

No experiments on the elimination of this mould have been carried out. *Stysanus stemonitis* is one of the Fungi Imperfecti belonging to the family *Stilbaceae*. In this family the conidiophores, instead of being individual structures as in *Dactylium* and *Verticillium* are combined to form compound fructifications known as fascicles or synnemata. These fascicles are 1—3 mm. high, dark grey and consist of a fine stalk bearing a club shaped head of spores. These spores are numerous and small, measuring 2.1 × 1.4μ.

*Miss Gandy was Microbiologist to the Mushroom Research Association, Yaxley from August 1951, to September, 1954.

CAMPESTRIN

S. R. Bose, commenting in Nature (Volume 175, p. 468) on the antibiotic obtained by Atkinson from *Psalliota xanthoderma*, reports finding an antibiotic in *Psalliota campestris* (L.) Fries.

Animal experiments have shown the crude extract to be non-toxic and clinical trials in typhoid cases gave encouraging results.

A concentration of the crude extract has been found to be more potent and has been used with favourable results in seven severe cases of typhoid in Calcutta. The name proposed for this antibiotic is campestrin.

P. B. FLEGG.

THE CULTIVATED MUSHROOM
12—EVOLUTIONARY CYCLE

By ANDRÉ SARAZIN
(Translation by Dr. C. J. Touche)

The study of the evolutionary cycle of the Cultivated Mushroom is of great importance. Indeed, an intimate knowledge of this cycle serves to enlighten the research worker regarding the career of cultivated varieties. It is therefore also of the greatest interest to the informed mushroom-spawn producer who is untiring in his efforts to improve by strictly scientific selection the varieties which he places at the disposal of mushroom growers. Science takes account of the phenomena of heredity and variation in species of living organisms through the special study of Genetics, and its work on the higher plants which is now being carried out on sound secure foundations is progressing by gigantic strides. Unfortunately the same does not apply to the fungi. Concerning them, the difficulties involved in cytological investigations due to the minuteness of the nuclei and variations in behaviour which derive from a certain morphological plasticity due to physicochemical conditions of the medium conspire to make the task of the research worker immensely complicated. Nevertheless, during these last few years, as a result of intensive research on the sexuality of the Ascomycetes and Basidiomycetes it has been possible to sketch in broad outline the evolutionary cycle of the Cultivated Mushroom. This was achieved either by applying the results derived from the study of the Ascomycetes to the Basidiomycetes or *vice versa*, or by comparing the results obtained from the study of more closely related species which were more suitable for these investigations. Furthermore this work has made it possible for the Cultivated Mushroom to be studied from a genetical point of view. (The works of the following authors should be consulted:— Beadle and Coonradt 1944, Lindegren 1948, Pontecorvo 1946, Rizet 1949, Sansome 1946, Buller 1941, Kuhner 1946, Quintanilha 1933, 1935, Vandendries 1937).

This treatise thus comprises two parts, the first being the study of the evolutionary cycle proper, the second, which derives from the first, being an account of the problems arising from the study of the genetics of the Cultivated Mushroom.

1. Study of the Evolutionary Cycle of the Cultivated Mushroom

The Study of the nuclear phenomena of the Cultivated Mushroom which have been already described enables one to foresee that the spore which receives two nuclei (apparently of opposite sexes) would appear to be bisexual at the time of its initiation. It may be seen that the Cultivated Mushroom is homothallic, and alone the fact of knowing that a single spore culture is fertile, in other words that the mycelium resulting from a single spore produces normal carpophores, is a confirmation of this. It is the opposite of what obtains in heterothallic fungi in which

only the secondary mycelium which results from the conjugation of two haploid or primary mycelia, each derived from complementary basidiospores, is fertile, in other words, produces carpophores. (It is outside the scope of this treatise to review the different schemes representing the sexuality of the Basidiomycetes; those interested, therefore, should consult the excellent work of Quintanilha (1941-1944), Vandendries 1937, Whitehouse 1949, etc.) And so to sum up, in heterothallic fungi, each of the spores is not potentially fertile, whereas in homothallic fungi each spore is theoretically potentially fertile or self-fertile.

Lambert (1920) was the first to obtain normal carpophores in single spore cultures; Kliousnikova (1938) and I myself (1939) through intensive experimentation have confirmed these results. But the fact that a single spore culture is fertile is not, for all authors, a proof of homothallism. Already in 1925, 1927, Bauch, basing his conclusions on observations made on bisporous varieties of normally tetrasporous basidiomycetes, had postulated a uniquely haploid parthenogenetic cycle. On the other hand, Buller (1941) considered that the Cultivated Mushroom was an example of haploidism in a heterothallic species. Kligman (1943) strongly contested these views. Indeed, if it is possible to obtain occasionally a few carpophores on haploid mycelia of heterothallic basidiomycetes (Quintanilha 1933, 1935, Chow 1934), these haploid carpophores are always atypical and their development is abnormal. They are the result of spontaneous diploidisation due to the mutation of a primary haploid mycelium which has remained in the haploid state, sometimes for a period of several weeks, or else they originate through a parthenogenic process. To be sure, haploid mycelia of heterothallic basidiomycetes do not possess clamp-connections and their nuclei do not divide by conjugate division, a feature which is also characteristic of single spore cultures of the Cultivated mushroom. But the characteristics of single spore mycelia and of the carpophores derived from them are identical with those of multiple spore mycelia and carpophores of the Cultivated Mushroom. Moreover, the nuclear behaviour, viz., the presence of two nuclei in the basidium fusing to form a diploid nucleus, the reduction division which follows this fusion, and the migration of the two nuclei of opposite sex into each of the two basidiospores, precludes the hypothesis that carpophores are formed normally on single spore mycelia by parthenogenesis.

Since homothallism in the evolutionary cycle of the Cultivated Mushroom may be considered as an established fact, what sexual significance can be attributed to nuclear fusion in the basidium followed by reduction division when the basidium reaches maturity?

Should one interpret this fusion as a sexual process, fertilization, the caryogamy of two nuclei of opposite sex, or, should one, with Kligman, consider this to be a simple pairing off of the two energids of a single body, the nuclei being, not of opposite sex but derived from the same parent nucleus. In fact this is what Kligman said:

"An analysis of nuclear division in the terminal cells has shown that daughter nuclei are apparently not prevented from remaining in

the same cell, so much so that it is quite probable that the two nuclei that fuse in the basidium are not of opposite sex. It has been suggested that *Agaricus campestris bisporus* as well as other homothallic hymenomycetes might be considered as being asexual. According to this view the fusion of the nuclei in the basidia of homothallic hymenomycetes represents a vestigial feature which has lost all genetical significance. This moreover consolidates the thesis that in sacrificing the advantages of hybridisation to self-fertization homothallic species have arisen from heterothallic species."

My observations incline me to accept the first hypothesis, a hypothesis which rests on delicate premises and which still necessitates much more patient investigation. It should first of all be pointed out that, when in the Cultivated Mushroom mycelium is fertile, this does not occur in pure culture but in fermented compost planted with spawn derived from such mycelium. Now cytological studies have been carried out on pure culture mycelium and on carpophores, but not on mycelium from the depth of the compost bed. Moreover the mycelium does not bear fruit until it has dwelt in the compost, during which time a profound morphological transformation takes place, to wit, the formation of thick filaments or mycelial strands. Is this transformation of vegetative mycelium into fruit-bearing mycelium brought about solely by the physico-chemical conditions of the medium which exert their influence on the innermost cellular structure of the mycelium to produce in it a cytological alteration which governs the future course of the mycelium? Only very intensive studies along these lines can elucidate this problem. It has already been stated that when a pure culture is made from a mycelial strand which has been dissected to extract its core of large cells the regenerated mycelium develops only strand mycelium.

When the young hymenium in a small carpophore forms a palisade of hyphal tips, these hyphal tips do not present the same pattern of cytological behaviour as that exhibited in a hyphal tip in actively growing mycelium. In fact there is a gradual reduction in the number of nuclei from the cells of the trama to the cells of the hymenium which are all short and binucleate. The parts of the hymenium in a young developing carpophore seem to originate in a special growing zone which is present in embryonic form in the very young carpophore. This zone lines the base of the annular gill-cavity. The nuclear behaviour in this zone would suggest that it is a centre of cell multiplication, but the intermingling of the hyphae is such that the interpretation of sections made at this level is very difficult and requires further exhaustive investigation. To sum up, it seems that what will become the hymenium in the mature carpophore exists in 'seed' form in the very young carpophore with its own nuclei derived directly from the mycelial strand. The hymenium develops along with the living carpophore somewhat as a parasite and is nourished by the plectenchyma which forms the greater part of the carpophore: that is to say the plectenchyma which develops from the growing zone (described in the chapter on morphology) which is situated at the junction of the stalk and cap.

It is well-known that if the hymenium of a young carpophore is planted in culture it will regenerate a normal mycelium vegetatively. Each young basidium produces a hypha (fig. 59). Now this newly-formed mycelium receives automatically the two nuclei from the basidia. I actually stained fixed preparations in order to record the behaviour of these growths. But if the two nuclei do migrate automatically from the basidium into the developing hypha it is reasonable to suppose that they are necessary to the development of the mycelium and hence are of opposite sex.

Fig. 59. Photomicrograph x 580.
Culture of young hymenium in which the basidia have regenerated normal hyphae.

The factual evidence which enables us to consider that the caryogamy which occurs in the basidium at maturity is actually a sexual process is as we have just seen somewhat flimsy and the problem requires much research. It is still too soon to give an outline of the complete evolutionary cycle of the Cultivated Mushroom, but the known facts may be summarised below.

The Cultivated Mushroom, *Agaricus campestris bisporus*, is a homothallic basidiomycete fungus; in other words, the mycelium obtained directly as a result of the germination of a single spore is, by and large, capable of producing carpophores when it is planted in a bed of compost. Although the first nuclear division in the spore takes place in each of the nuclei of opposite sign which the basidium expels into each basidiospore one is not justified in regarding this nuclear division as the first manifestation of a prolonged dicaryophase.

Indeed at the onset of the germination of the basidiospore one is immediately confronted with a symplastic phase and the first nuclear

divisions reveal the complete independence of the nuclei of the two pairs which migrate from the spore into the germ-tube. It seems that, as far as the difficulties of cytological investigation permit, there is little likelihood that a typical dicaryophase exists during the vegetative period of the mycelium. This mycelium is heterocaryotic, in other words, the nuclei of different genetic origin are dispersed in about equal numbers in the cells of the mycelium. Anastomoses between the hyphae enable nuclear exchanges to take place. Exact studies are still necessary to reveal the phenomenon which accounts for the presence of two nuclei of opposite sign side by side in the basidium. After the nuclear fusion which takes place in the basidium reduction division follows, during which there is a segregation of the genes which bear the hereditary characters of the cultivated species.

Genetics of the Cultivated Mushroom

As observed by Kligman (1943) the homothallism of the Cultivated Mushroom precludes in principle any possibility of the creation of new strains by hybridisation, in other words by the process of crossing. Nevertheless mushroom growers of bygone days were acquainted with producers of virgin spawn, who, each year, in the spring, offered them more than ten new strains to try out. No-one knew how these strains were obtained, for the empirical procedures by which they were produced became extinct with the clever and intelligent practitioners of that period who knew how to preserve their secret.

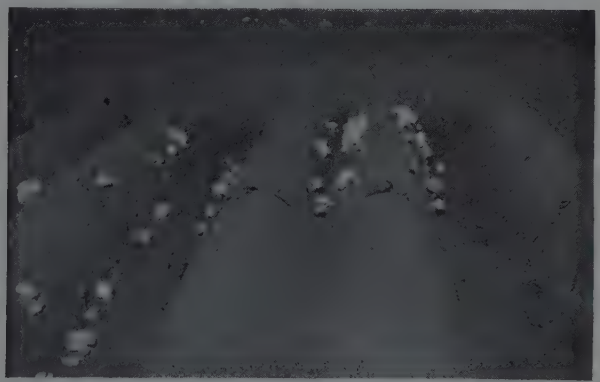

Fig. 60. Comparative tests with single spore and multiple spore strains of the same variety.
In foreground, two sterile single spore strains.
In background on right, very prolific single spore strain.
In background on left, prolific single spore strain.
Along left side at back, moderately prolific single spore strain.
Along left side in front, multiple spore control strain.

The practice of producing mushroom spawn from spore cultures has made it possible for the better cultivated varieties to be preserved and in due course improved. On the other hand, what is known of the evolutionary cycle of the Cultivated Mushroom does not actually, by reason of the homothallism of the fungus, enable one to explain the appearance of new strains unless it be by means of hypothetical mutations.

The propagation of the Cultivated Mushroom is usually carried out by sowing spores in mass quantity, in other words by multiple spore culture. Now, if one proceeds by means of single spores and if several single spore cultures are grown side by side in beds of the same compost, marked differences may be observed, either in the rate of growth of the spawn or in the quality or quantity of the carpophores produced. Kligman (1943) stated at the outset that, out of a spore crop, 10 to 20 per cent. of the cultures are sterile, in other words are capable of producing only a few carpophores or none at all. Certain single spore strains are definitely more interesting than the multiple spore strains on account of the quality or quantity of the carpophores produced; others on the other hand are less interesting (fig. 60). I recorded (1939) that the appearance and the rate of growth of the single spore colony in pure culture enabled one to predict the quality and quantity of its yield on the mushroom farm (fig. 61). Since then, my numerous daily

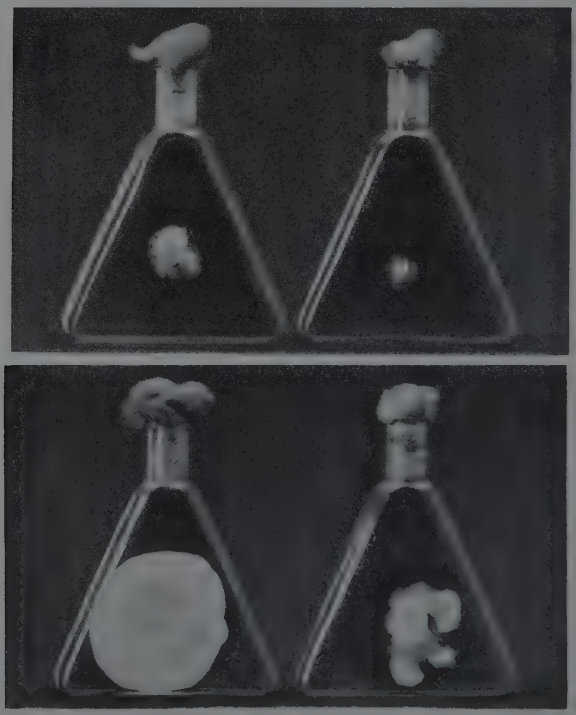

Fig. 61. Different appearances of single spore strains in pure culture.
1. Very small tufted growth.
2. Slow low-lying growth ceasing abruptly (8 days).
3. Extremely vigorous mycelium.
4. Mycelium with a few very actively growing tufts.

records have substantiated these views. In this matter I am at variance with Kligman who can see no correlation between the appearance and total growth of single spore colonies in pure culture and the results obtained on the mushroom farm. What I interpreted in 1939 as a lack of vigour Kligman identifies as a sterility factor. Since then I have encountered single spore mycelia which exhibited definitely the phenomenon of sterility and, generally speaking, any mycelia which are atypical in pure culture do not give rise to strains which are interesting from the point of view of carpophore production. Certain single spore strains enable one to recover the typical characteristics of the variety in cultivation and to accentuate them. Indeed, under the influence of intensive cultivation these characteristics exhibit progressive variation, but some of them are worth preserving and it is possible by means of a rational rotation of multiple spore and selected single spore cultures to stabilize and even improve these useful characteristics (fig. 62). Such typical characteristics are not only of a morphological but also of a physiological nature. To explain the divergence of my views and those of Kligman one should perhaps emphasize the fact that, in France, different varieties and different strains of these varieties are under cultivation. The mushroom grower and spawn producer pay much more attention to these characteristics: of a morphological nature (in so far as concerns the relative size of the cap and and stalk), and of a physiological nature (in so far as concerns the vegetative growth of the mycelium and the production of carpophores in relation to the nature and degree of decomposition of the compost and the ventilation and temperature of the caves).

A curious result obtained by Kligman is the fertilization which takes place by contact between two sterile mycelia. This author brought together two single spore mycelia known to be sterile and on the fringe of each culture where they intermingled the mycelium was capable of giving rise to carpophores. This crossing is not strictly speaking a conjugation of two haploid mycelia and Kligman interprets it as a sort of reciprocal activation of both mycelia when they come into contact.

Cultures grown from multiple spore strains are always fertile and Kligman attributes this result to the numerous anastomoses which occur between the hyphae resulting from different spores in the inoculum usually while germination is taking place in a multiple spore culture, the spores which germinate first give rise to a more actively growing

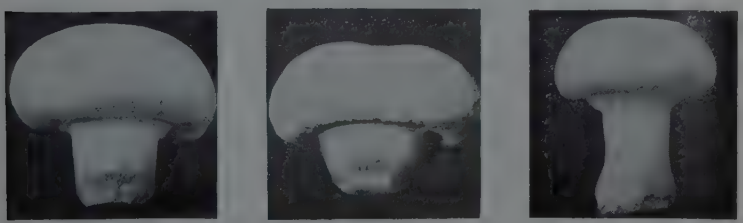

Fig. 62. Three typical appearances of carpophore shapes produced by three single spore strains of the same variety.

mycelium which by its presence inhibits the germination of those spores which are slower to germinate. Anastomoses therefore take place between hyphae which are potentially of equal value; furthermore it is possible to assert that the characteristics of a multiple spore strain represent the average of the characteristics of the most active of the single spore strains which could be isolated from this inoculum. For the selection of cultivated strains it is of interest to take into consideration the variations which are exhibited by various single spore strains. In order to effect this a micro-manipulator is used (fig. 63). Since spores when planted singly do not germinate one must have recourse to an artifice: with the help of a micro-manipulator and using a mass inoculum each spore is picked up as it begins to germinate; and when thus isolated from one another they are put into culture. It is a hard task requiring much patience, for it is necessary to isolate several hundred spores from an inoculum in order to obtain occasionally a single favourable strain. Moreover, these strains have to be grown on the mushroom farm in order to retain only those which are of real interest.

If the spores of different varieties are mixed, for instance a white variety with a cream or light coloured variety (blond), the spores germinate normally but the mycelia grow side by side without influencing each other and the carpophores which develop on a bed which is planted with this type of spawn retain their respective characteristics; in other words they remain white, cream or light coloured (blond) according to the varieties included in the mixture, although they grow up beside one another indiscriminately.

Sometimes on a mushroom farm a brown or cream variety may show a tendency to produce occasionally lighter coloured carpophores or even absolutely white ones. If propagation is carried out by

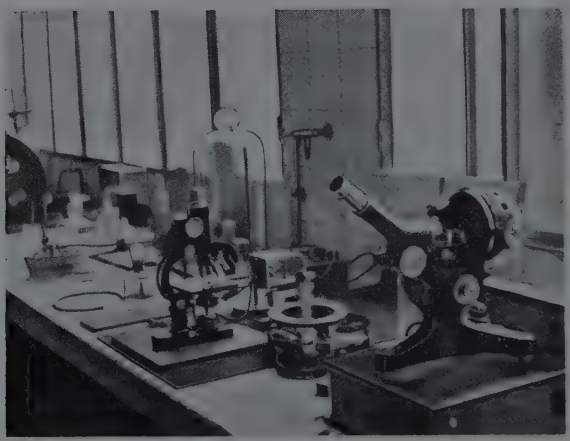

Fig. 63. De Fonbrune micromanipulator.
On right, microforge for manufacturing microtools.

means of these carpophores brown or cream carpophores are again obtained. This chance variation in shade is therefore not a stable hereditary factor and is due only to certain cultural conditions. These observations furthermore lead me to consider with scepticism the view accredited to the U.S.A. which is that the white variety cultivated in that country is the result of a mutation which occurred on beds planted with a cream-coloured strain (Kligman 1951).

Mutations do occur but they almost invariably reveal characteristics which do not recommend themselves for cultivation purposes. They are nearly always hereditary malformations of the carpophores or a partial sterility of the hymenium (known as " Open Veil " or " Gill-less Mushroom ").

Procedures by which polyploidisation is brought about in the higher plants are not effective in the case of the cultivated mushroom.

Experiments with colchicine and various narcotics influencing mitosis were negative. Recently Wahl (1949) obtained a cream-coloured mutation from white varieties under the influence of Uranium salts.

X-rays and ultra-violet rays are effective but so far the mutants have not shown any features which are of interest from the point of view of cultivation.

In matters of selection, where the cultivated mushroom is concerned, the only features which count are those which are likely to improve the cultivated strains and which will satisfy the requirements of the mushroom growers who are always on the look-out for strains capable of producing flush after flush and innumerable large white fleshy mushrooms.

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I Have Been Asked . . . . . .

ABOUT NITROGEN SOURCES for COMPOST ACTIVATORS

Dr. R. L. EDWARDS

Compared with pre-war years there has been a great change in the last decade to the use of much lighter manure for mushroom growing, and a very large proportion of it now comes from racing stables, where straw is more freely used and the manure consequently has a smaller proportion of droppings. Much of this manure can be improved by the addition of Activators, mainly to supply additional nitrogen. The balanced Activators designed for use with straw alone to make synthetic compost are also suitable for this purpose, and the poorer the manure in droppings, the more valuable are such Activators compared with those supplying nitrogen only.

Cost is of course a major consideration in choosing an Activator, and for this purpose the main relevant factor is cost per unit of nitrogen. The simplest way of comparing these costs is to divide the price per ton by the percentage of nitrogen in the material minus 2, giving a cost per cwt. per 1% of available nitrogen. The " minus 2 " is because the material itself requires 2% of nitrogen, as part of the compost.

Thus if dried blood and urea cost the same, say 63s. per cwt., urea with 46% nitrogen costs $\frac{63}{44}$ shillings per unit, or about 1s. 6d., whereas dried blood with 12% nitrogen costs $\frac{63}{10}$ shillings per unit, or about 6s. 4d., four times as much.

Of course cropping power must also be taken into account, and many of the cheap sources of nitrogen were tried at Yaxley and found to give lower yields than dried blood in synthetic composts. I do not know of any equally exhaustive tests on their performance as supplements to racing manure. The only material I found to give results equal to those from dried blood was urea, which is very much cheaper per unit of nitrogen, but has not been generally available owing to the demands of the plastics industry. However, there seems to be more hope that it will be available in future.

It is curious that there should be so much difference in the use of Activators in various countries. For many years it has been the general practice in France to add sulphate of ammonia to manure, but this fertiliser is hardly used here or in U.S.A. In this country probably the most popular Activators are dried blood, poultry manure and published or proprietary compounds such as the MRA formula and Adco M.

In U.S.A. urea is widely used, and also as a much less concentrated supplement, brewers' grains. This material has the additional effects of supplying active fermenting organisms and some fermentable material which helps to heat the compost quickly. A few growers here use brewers' grains, but generally they are in great demand for animal feeding, and are not readily available to mushroom growers.

German growers have found another waste product with rather similar characteristics to brewers' grains, in brewery and distillery " slop," liquid waste from the yeast fermentation processes. I have made some enquiries about the possibility of obtaining similar material

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here, but the results were not very promising, and I did not reach the stage of experimenting with it.

The difficulty with any of these Activators is that one has to decide afresh for each delivery of manure how much Activator, if any, is needed. If too little is used the maximum possible crop will not be obtained. A small excess is wasteful, but no worse, while a large excess may be converted into so much ammonia that it is difficult to remove it from the compost, and growth of spawn may be delayed. It is just another instance of the need for skilled judgment in mushroom growing.

STOP PRESS

SINDEN and HAUSER, world authorities on Mushroom Growing, have both promised to lecture at the Annual Mushroom Industry Exhibition, Brighton, on 5th & 6th October next.

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THE FRED. ATKINS ALPHABET—Q/R

Quality. There would be no need to grade our mushrooms if we could control their quality. We can't begin to do that until we know what governs quality. Is it the compost, the casing, water, ventilation, air movement, spawn—or a complex combination of all these and other factors?

Quick Freezing. What little I know of quick-freezing mushrooms come from the States, where I hear the flavour is lost unless the mushrooms are first fried. But we may hear more of this subject before very long.

Ramularia sp. This parasitic fungus was found by Bulloch to cause a brown patch on the mushroom cap.

Rapid Composting. The Sinden-Hauser short method of composting is fully described in *Mushroom Science* 2 (obtainable from the MGA at 12/6d., post free). Growers, they say, must understand the processes if the maximum benefit is to accrue—but few growers appear to.

Rating. Horticultural buildings are de-rated at the moment. The MGA is watching the position closely.

Rats. Rats are not fond of mushrooms, but they can't resist grain, even though it be coated with mushroom mycelium.

Recipes. I came across a new book the other day which everyone who eats mushroom or wants others to eat them should possess. It may (it should) be obtainable from Secretary Alderton. It is Lapolla's Mushroom Cooking, published by Deutsch at 7/6d. The preface alone is worth the money!

Records. The question is no longer "Need I keep records?" but "What ought I to record?"

Red Geotrichum. See *Geotrichum.*

Refresher Courses. We must wait for Brighton, it seems—but from what I hear it will be worth waiting for.

Research. What problems most urgently require investigation? I have my own views, but they aren't everyone else's, of course. A survey of what worries most growers most always makes interesting reading, and another is about due, I would have thought—while Littlehampton is in the throes of building.

Respirators. An ordinary gas-mask isn't much good for very long as a protection against formaldehyde. Get special respirators for specific gases.

Rhabditis spp. These nematodes are unable to puncture the mycelium as do *Ditylenchus* eelworms, and the absence of a stylus-type mouth is a rough means of differentiation. But if they don't suck food from the mycelium they are nevertheless very harmful. Sarazin tells me the tissue can be destroyed by toxic substances secreted by nematodes. Perhaps this is how the *Rhabditis* family do their dirty work.

THE PROOF OF THE SPAWN—
IS IN THE CROPPING!

Messrs. R. H. & R. S. Fryer, and below, a view of their farm at Chesham.

NASHLEIGH MUSHROOM FARM Ltd.

Market Gardeners

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C. S. Fryer
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6th November 1954

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Worthing

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You have an order for 51 quarts of Moist White Spawn for delivery on 15th November. Will you please alter this and despatch immediately on the arrival of this letter.

You may be interested to learn that in a current crop on shelves we have just produced 2 lbs per sq. ft. in 3 weeks 4 days. The third flush is still producing and it seems likely that by the end of this flush the crop will have achieved 2½ lbs in a day or two over four weeks.

Yours faithfully,

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WORTHING • • • SUSSEX

Rhizoglyphus sp. (*phylloxera*?). These very common glassy-white mites move slowly, largely because they are so tubby, perhaps, but not, I assure you, because they don't like mushroom spawn. My dear, they *adore* it!

Rhubarb houses. Many mushrooms are grown in these dark houses in the summer months, particularly in the West Riding of Yorkshire.

Riboflavin. Mushrooms have a considerable claim to be included among the " protective foods," says Edwards. Among other vitamins they contain 0·5 mg. of riboflavin (vitamin B_2) per 100 grams.

Ridge Beds. It seems many years since I last saw ridge beds in England; is the wasteful practice dying out?

Rose Comb. A general name given to malformation of mushrooms, particularly where rudimentary gills appear *outside* the cap. The possible causes are various, and are not confined to fumes from mineral oil.

W. A. B. HARDING (Tenterden Mushrooms Ltd.), *says:—*

" JUST THE JOB "

A portable quick steaming boiler has just come on the market which appears to fill a long standing gap for peak heating Mushroom Sheds and for soil sterilizing for the smaller grower, many of whom combine mushroom growing with other horticultural activities.

Growers may have received descriptive circulars from the suppliers and the opportunity seems well worth further investigation, particularly as we learn that many growers have already installed one of these units with very satisfactory results.

A suitable perforated steam line and flexible hose to suit individual requirements is offered, together with Hoddesden pipe equipment for sterilizing soil if required or the necessary dual units for John Innes " High Rate Sterilizers " for potting soil.

Although the standard boiler is normally arranged for solid fuel burning, the suppliers can equip with an oil burning unit for T.V.O. which they claim gives excellent results.

There are two sizes of boiler available, each of which is supplied with full equipment of steam and water mountings, including injector and auxiliary hand feed pump, also chimney, the whole being mounted on large diameter wheels for easy haulage. The smaller unit weighs only $7\frac{1}{2}$ cwt. and the larger 10 cwt.

The choice of equipment to suit individual growers is a great advantage where there is no call for the large and cumbersome Loco type boiler which has up to now been the usual practice.

The suppliers, appropriately terming their unit "a boon to Mushroom Growers," will send details and photographs to those interested, carry out a demonstration and put in touch with other members of MGA who have proved this plant of service to them.

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PUBLICITY — Thoughts and After-Thoughts

By GUY V. REED (*Chairman, MGA Publicity Sub-Committee*)

At 10.30 tonight, while toasting myself by the fire, thawing from my bones the chill of sixty long cold miles of icy roads, the telephone rang . . . It was trunks calling . . . . Raymond Thompson, full of enthusiasm about a scheme he had hatched for discussing at our next Publicity Sub-Committee meeting; and with the glad tidings that one of the Spawn Makers had just revealed that over 80 per cent. of his spawn customers were contributing to the Publicity Fund through the Spawn Scheme . . . . all that at 10.30 at night, mark you! I reciprocated with the news of the journey from which I had only just returned. I told him of my visit to a certain lady (a writer, speaker and television personality who specializes in women's interests in the home). I had gone down to her place armed with a bundle of information about mushrooms, for her use as material for her various professional activities, including a television broadcast she was about to make.* It was good to hear one another's news of the day—even so late at night. I put down the telephone and returned to the fire.

. . . . 80% of that Spawn Maker's customers . . . . all contributing to the Publicity Fund and voluntarily . . . . rather an inspiring thought. There was something very British, something more warming than the fire, about it . . . . something that made the sixty icy miles very worth while and the more so because that journey, like all the committee's work, was voluntary too. Funny, isn't it, how much we'll do voluntarily?

Gradually I fell into wondering about that other 20%—How about them?—Who were they? Were they perhaps young men not yet experienced in the ways of business and the power of publicity? . . . . or were they experienced men who know the way but prefer to " hitch-hike " there on the efforts of others? Are these who stand aside just complacent or self satisfied? Then, at this point, it dawned on me . . . . maybe they're none of these things. Maybe I was the self satisfied one: maybe I was the one at fault! . . . . Here was I assuming that, because the MGA had launched this scheme everyone had heard about it . . . . here was I assuming that everyone knew what the MGA was doing, where it was trying to go and why the money was needed to get there. Quite possibly this 20% hadn't read or heard anything about the scheme. So back to the telephone I went (time of night be damned!) I rang Winston Alderton (our never tiring Secretary and Editor of the Bulletin). Certainly he would hold space in the Bulletin, certainly he would enclose a postcard questionnaire with that Bulletin. So here is the postcard enclosed in these pages and here is the space filled by the tale of to-night. The main object is to gather in that other 20%, for either you are contributing already or you didn't know enough about the scheme to do so. That's right, isn't it?

In either event please post this card to us now. It'll help us to help you more still. You won't have to drive sixty miles to do so! You don't even have to stamp it. Thank you and Good Night.

*For a report on the successful result of this television broadcast see pages 515-516 of the March Bulletin.

STEADY SUPPORT FOR PUBLICITY

It is with pleasure that the Publicity Committee report that steady support continues to be received for the Publicity Fund and additional contributions to 21st March, include:—

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*C. Snowden & Co. Ltd., Castlefolds Market, Sheffield (Salesmen)	2	17	10

*Previous contributions already acknowledged.

†Amounts donated by Spawn Merchants are not, for obvious reasons, given here.

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SALE few thousand ex Ammo. Boxes, 38″ × 18″ × 6″ deep, 36″ × 14″ × 6″ deep, suitable for mushroom trays. Also 12 9 ft. lengths conveyor rail, with bend and stands, £3 per 9 ft. length. WHARRAM, The Mount, Jenny Brough, Hessle, E. Yorks.

MAGNESIAN LIMESTONE cures magnesium deficiency in apples, tomatoes, and other market garden crops. COOPERS, Limeburners, Canterbury.

Nr. TUNBRIDGE WELLS, KENT. First-class purpose built mushroom farm providing 20,000 sq. ft. of beds with all necessary ancillary buildings. Very pleasant well maintained 4-bedroomed residence. Main electricity, water and drainage connected. Freehold £10,000. Inspected and recommended. GLADDING, SON & WING, F.R.I.C.S., 14a Ship Street, Brighton, 1. Tel. Brighton 23284.

(Continued on inside back cover)

Attention all Mushroom Growers ! ! !

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LANGSTAFF'S FRESH LONG WHEAT STRAW STABLE MANURE

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ANNUAL MUSHROOM INDUSTRY EXHIBITION

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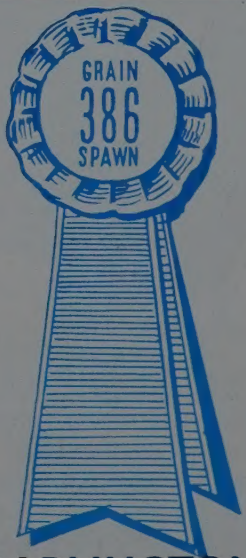

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SMALL ADVERTISEMENTS—(*continued from page 571*)

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